and Sydney was in progress, and, on this being completed, there would only remain to connect Western Australia, to have the longitudes of all the chief Australian and New Zealand cities and ports determined upon the same system.

Mr. Ellery recommends that a small expedition should be despatched from Melbourne to New Zealand for the observation of the total eclipse of the sun on September 9 in the present year, when the central line passes through Cook's Straits. Sir W. Jervois, the Governor of New Zealand, had promised all the aid he could render in the matter. The Board of Visitors supported an application to the Government of Victoria for the necessary funds. [Full details of the circumstances of this eclipse were given by Mr. Hind in the *Monthly Notices* of the Royal Astronomical Society for January last.]

## *ASTRONOMICAL PHENOMENA FOR THE WEEK*, 1885, *MARCH* 8–14

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

*At Greenwich on March* 8

Sun rises, 6h. 31m.; souths, 12h. 10m. 51·6s.; sets, 17h. 51m.; decl. on meridian, 4° 42′ S.: Sidereal Time at Sunset, 4h. 57m.

Moon (at Last Quarter at 19h.) rises, 1h. 5m.; souths, 5h. 40m.; sets, 10h. 12m.; decl. on meridian, 17° 25′ S.

| Planet | Rises h. m. | Souths h. m. | Sets h. m. | Decl. on Meridian ° ′ |
|---|---|---|---|---|
| Mercury | 6 36 | 11 56 | 17 18 | 8 22 S. |
| Venus | 6 13 | 11 18 | 16 23 | 11 26 S. |
| Mars | 6 28 | 11 52 | 17 16 | 7 44 S. |
| Jupiter | 15 46 | 22 58 | 6 10* | 13 8 N. |
| Saturn | 9 56 | 18 0 | 2 5* | 21 41 N. |

* Indicates that the setting is that of the following nominal day.

*Occultations of Stars by the Moon*

| March | Star | Mag. | Disap. h. m. | Reap. h. m. | Corresponding angles from vertex to right for inverted image ° ° |
|---|---|---|---|---|---|
| 10 | B.A.C. 6287 | 6 | 4 25 | 5 38 | 90 228 |
| 10 | B.A.C. 6292 | 6 | 5 6 | 6 26 | 54 280 |
| 11 | $\rho'$ Sagittarii | 4 | 5 18 | 6 38 | 60 272 |

*Phenomena of Jupiter's Satellites*

| March | h. m. | | March | h. m. | |
|---|---|---|---|---|---|
| 8 | 2 46 | II. ecl. reap. | 13 | 0 27 | I. occ. disap. |
| | 6 12 | IV. occ. disap. | | 3 14 | I. ecl. reap. |
| 9 | 20 8 | II. tr. egr. | | 19 1 | III. tr. ing. |
| 10 | 5 23 | III. occ. disap. | | 21 45 | I. tr. ing. |
| 11 | 6 0 | I. occ. disap. | | 22 39 | III. tr. egr. |
| 12 | 3 19 | I. tr. ing. | 14 | 0 5 | I. tr. egr. |
| | 5 38 | I. tr. egr. | | 18 53 | I. occ. disap. |
| | | | | 21 43 | I. ecl. reap. |

The Occultations of Stars and Phenomena of Jupiter's Satellites are such s are visible at Greenwich.

March 13, 19h.—Mercury in superior conjunction with the Sun.

## *RECENT ENGINEERING PATENTS*[1]

SIR FREDERICK BRAMWELL stated that he had been determined in his choice of a subject by the consideration that H.R.H. the Prince of Wales had seen fit to appoint him chairman of the Executive Council of the International Inventions Exhibition, to be held at South Kensington this year. He therefore proposed to direct attention to some of those objects that ought to be contributed to that Exhibition which were more particularly connected with civil engineering.

Dealing, first, with materials of construction, the President remarked that probably few materials had been more generally useful to the civil engineer, in works which were not of metal, than Portland cement. During the last twenty-two years great improvements had been made in the grinding and in the quality of the cement. As regards bricks, although not now superior in quality to those made by the Romans, there was progress to be noted in the mode of manufacture and the materials employed. The brick-making machine and the Hofmann kiln had economised labour and fuel, while attempts were being made to utilise the waste of slate quarries. Certain artificial stones appeared at last to be produced with such a uniformity and power of endurance as to compare favourably with the best natural stone, or were even better, for they could be produced of the desired dimensions and shape, and were thus ready for use, without labour of preparation. The employment of wood, except in newly-developed countries, was decreasing, for one reason, because it was practically impossible so to use it as to obtain anything approaching to the full tensile strength. Many attempts had been made to render timber proof against rapid decay and ready ignition, and it was in these directions alone that progress could be looked for. With respect to preservation from fire, the wooden structures of the Health Exhibition were coated with asbestos paint, and to this their escope from destruction by a fire was due. Leaving the old-world materials of stone and wood, attention was directed to that form of iron known as steel. The President remarked that, in his judgment, the making of steel in crucibles was not so satisfactory a mode of obtaining uniformity in large masses as was either of the other two great systems of manufacture—the Bessemer and the Siemens—the two processes which had changed the whole complexion of the iron industry. He further said that, eight years ago, in a lecture he delivered at the Royal Institution, he had ventured to predict that steel made by fusion would supersede iron made by the puddling process, and that the use of iron so made would be restricted to the small articles produced by the village blacksmith. The first important revelation in steel manufacture was the ingots shown by Krupp, with other products, in the Great Exhibition of 1851. These showed an enormous step at the time when the production of steel involved the employment of the crucible. Within the last eight years a great improvement had been made by Messrs. Thomas and Gilchrist, by which it had been rendered possible to employ successfully, in the production of steel, iron derived from ores that, prior to the date of this invention, had been found wholly inapplicable for the purpose. In the manufacture of pig-iron improvement had been effected by increasing the dimensions of the furnaces and the temperature of the blast, by the better application of chemistry to the industry, by the total closing of the bottom of the furnace, and by the greater use of the waste gases. Copper, so long used in its alloyed condition of "gun-metal," had, within the last few years, been still further improved by alloying it with other substances so as to produce "phosphor-bronze" and "manganese-bronze," very useful materials to those engaged in the construction of machinery. With the increased dimensions of the main-shafts of engines, and of the solid forgings for the tubes of cannon, obtaining at the present day, composed, as they were, of steel, the operations of light steam-hammers were absolutely harmful, and the blows of even the heaviest hammers were not so efficacious as was pressure applied without blow. The time was not far distant when all steel in its molten state would be subjected to presusre, with the object of diminishing the size of any cavities containing imprisoned gases.

Within the period under consideration the employment of testing-machines had come into the daily practice of the engineer, for determining, experimentally, the various physical properties of materials—and of those materials when assembled into forms to resist strain, as in columns or in girders.

In those matters which might be said to involve the principles of engineering construction, there must of necessity be but little progress to note. Principles were generally very soon determined, and progress ensued, not by additions to the principles, but by improvement in the method of giving to those principles a practical shape, or by combining in one structure principles of construction which had hitherto been used apart.

Taking up, first, the subject of bridge construction—the President thought the St. Louis bridge might fairly be said to embody a principle, novel since 1862, that of employing for the arch ribs tubes composed of steel staves hooped together. Further, in suspension bridges, there had been introduced the light upper chain, from which were suspended the linked truss-rods, doing the actual work of supporting the load, the rods being maintained in straight lines, and without flexure at their joints due to their weight. In the East River Bridge at New York, the wire cables were not made as untwisted cables, and then hoisted into place, imposing severe strains upon many of the wires, but the individual wires were led over from side to side, each having

[1] Abstract of Presidential Address at the Institution of Civil Engineers, by Sir Frederick J. Bramwell, F.R.S., on January 13.

the same initial strain. So far as novelty in girder-construction was concerned, the suspended cantilever of the Forth Bridge, now in course of construction, afforded the most notable instance. It was difficult to see how a rigid bridge, with 1700 feet spans, and with the necessity for so much clear headway below, could have been devised without the application of this principle. A noteworthy example of the use of pneumatic appliances in cylinder-sinking for foundations was also in progress at the Forth Bridge. At the New Tay Viaduct, the cylinders were being sunk while being guided through wrought-iron pontoons, which were floated to their berths and were then secured at the desired spot by the protusion, hydraulically, of four legs, which bore upon the bottom, and they, until they were withdrawn, converted the pontoon from a floating into a fixed structure.

The President next traced the contest between canals and canalised rivers as modes of internal transit, in contrast with railways, and referred to the improved rate of transport on canals by the substitution of steam- for horse-haulage, and by a diminution in the number of lockages. He also alluded to the hydraulic canal lift on the River Weaver, and to a similar application in the Canal de Neufossé, in France, for overcoming a great difference of level, and reducing the consumption of water and the expenditure of time to a minimum. The great feature, however, of late years in canal engineering, was not the preservation, or improvement, of the ordinary internal canal, but the provision of canals such as the completed Suez Canal, the Panama Canal in course of construction, the contemplated Isthmus of Corinth canal—all for saving circuitous journeys in passing from one sea to another—or in the case of the Manchester Ship Canal, for taking ocean steamers many miles inland. The rivalry between canal-engineers and railway-engineers was illustrated by the proposal to connect the Atlantic and Pacific oceans by means of a ship-railway, the details of which scheme were before the public.

In harbour-construction, the principle adopted in the Liffey at Dublin was referred to, where cement-masonry was moulded into the form of the wall, for its whole height and thickness, and for such a length forward as could be admitted, having regard to the practical limit of the weight of the block. The block was then carried to its place, was lowered on to the bottom, which had been prepared to receive it, and was secured to the wall by groove and tongue. The apparatus by which the blocks, weighing 350 tons each, were raised, and transported to their destination, was then described.

Consideration of sub-aqueous works necessarily led to appliances for diving; and here the President said a few words about the "bateau-plongeur" used on the "barrage" of the Nile. Beyond improvement in detail and the application of the telephone, there was probably no novelty to record in the ordinary dress of the diver. But one great step had been made in the diver's art by the introduction of the chemical system of respiration. A perfectly portable apparatus had been devised, embracing a chemical filter by which the exhaled breath of the diver was deprived of its carbonic acid. The diver also carried a supply of compressed oxygen to be added to the remaining nitrogen, in substitution for that which had been burnt up in the process of respiration. Armed with this apparatus, a diver during one of the inundations which occurred in the construction of the Severn tunnel, descended into the heading, proceeded along it for some 330 yards (the depth of the water above him being 35 feet) and closed a sluice-door through which the water was entering the excavations, and thus enabled the pumps to unwater the tunnel. Altogether, this man was under water for one hour and twenty-five minutes without any communication with those above.

There were, happily, cases of sub-aqueous tunnelling where the water could be dealt with by ordinary pumping power, and where the material was capable of being cut by a tunnelling machine. In the Mersey Tunnel, in the New Red sandstone, a heading 7 feet 4 inches in diameter, a speed of 10 yards in 24 hours had been averaged, while a maximum of over 14 yards had been attained. In the experimental Channel Tunnel in a 7-feet heading in the gray chalk, a maximum speed of 24 yards had been arrived at in the 24 hours on the English side, and on the French side of $27\frac{1}{3}$ yards in the same time. In ordinary land-tunnelling, since 1862, there had been great progress, by the substitution of dynamite, and preparations of a similar nature, for gunpowder, and by improvements in the rock-drills worked by compressed air, used in making the holes into which the explosive was charged. In boring for water, and for many other purposes, the diamond drill had proved of great service. Closely connected with tunnelling-machines were the machines for "getting" coal, which, worked by compressed air, reduced to a minimum the waste of coal, relieved the workman of a most fatiguing labour in a constrained position, and saved him from the danger to which he was exposed in the hand operation. The commercial failure of these machines was due to trade opposition, and it was to be feared that like prejudices would prevent the introduction of the lime-cartridge in lieu of gunpowder.

With regard to the great source of motive power—the steam-engine—it was difficult to point to any substantive novelty since 1862. But the machine had been more and more scientifically investigated, and the results had been practically applied with corresponding advantages. The increase in initial pressure, the greater range of expansion, the steam-jacketing of the vessels in which the expansion took place, had all led to economy. Double-cylinder non-condensing engines were now currently produced, which worked with a consumption of only $2\frac{3}{4}$ lbs. of coal per I.H.P., or 2·7 lbs. per H.P. delivered off the crank shaft, equal to 82 millions of duty on the Cornish-engine mode of computation. When these results were augmented by the employment of surface-condensation, an I.H.P. had been obtained for as low as $1\frac{1}{2}$ lbs. of coal, and it was commonly obtained, in daily work, for from 2 lbs. to $2\frac{1}{2}$ lbs. But in the use of steam as a heat-motor, the largest portion of the heat passed away unutilised. This defect had been sought to be overcome by a regenerative steam-engine, but it was not successful. Heated-air engines had hitherto only been found applicable where small power was required. Another form of heat-motor—the gas-engine—was daily coming into general use up to 30 I.H.P.. By a change in the mode of burning the mixture, and of utilising the heat thereby generated, the injurious shock of the early forms of gas-engine, and their large consumption of gas, were obviated. Comparing a gas-engine with a non-condensing steam-engine consuming 5 lbs. of coal per I.H.P. per hour, and demanding therefore, at one shilling per cwt., only one halfpenny for the purchase of coal, the extra cost for working the gas-engine was well repaid by the saving of boiler-space, of the wear and tear of the renewal of the boiler, of the consumption of coal while getting up steam and during meal-times, of the saving of wages, of the freedom from boiler explosions, and of the cessation of smoke production. A motor had been recently tried where no fuel was employed directly, but where a boiler, being filled with water and steam under pressure, had its heat maintained by exposing caustic soda, contained in a vessel surrounding the boiler, to the action of the waste steam from the engine, the result being that, as the moisture combined with the caustic soda, sufficient heat was developed to generate steam and keep the engine working for some time. Trials had been made with this motor for propelling a launch and for working a tramcar.

With respect to other motors, viz. those driven by wind or by water, in France an improvement had been made in water-wheels by which it was asserted that 85 per cent. of all the energy residing in a low fall of water had been converted into power. In turbines also there had been considerable development during the last twenty-two years, and they were very efficient where a high fall of water had to be utilised, or where, in the case of a low fall, great difference in the working head, and in the level of the tail-water, had to be provided for.

Next to the subject of motors came the transmission of power. In its restricted sense, the transmission from one part of a machine to another, reference might be made to the increasing use of multiple-rope driving-gear in lieu of belts, to inclined spur-gear for diminishing noise, and to that kind of frictional gearing to which the name of "nest-gearing" had been given. Where, however, the transmission was to long distances, means were being adopted for supplying power—*i.e.* water under pressure or compressed air—through mains laid down in the streets, in a manner similar to that in which gas and water were now supplied for domestic use; and in New York and other cities of the United States high-pressure steam was similarly conveyed and delivered to the consumers, both for power and for heating.

Sir Frederick Bramwell also remarked upon the continuous rolling of bars of steel for tyres, upon the right way of making boiler-shells and boiler-flues, upon tidal motors, upon "dirigible" balloons, upon the Maxim machine-gun, and upon the application of submarine mines and torpedoes for the defence of seaports. In regard to waterworks, he could not adduce any material improvements in those dependent upon storage, or in

pumping machinery; but in the matter of house-fittings there had been great progress, especially in the detection and prevention of waste of water. With respect to gas as a distributed illuminant, considerable improvements had lately been made, due to a greater liberality on the part of lighting-authorities, and to the use of multiple burners in street-lanterns, by which a greater amount of light was obtained from the same volume of gas. The regenerative gas-burners, and other modes, promised largely to increase the candle-power per cubic foot of gas burnt.

In conclusion, the President stated that, during his term of office, he would do all that lay in his power, as he had done in the past, to uphold the honour, the dignity, and the usefulness of the Institution; and in these efforts he felt satisfied that all the members would cheerfully and gladly assist.

## *HOW THOUGHT PRESENTS ITSELF AMONG THE PHENOMENA OF NATURE*[1]

EVERY phenomenon which a human being can perceive may be traced by scientific investigation to motions going on in the world around him. This is obvious to every scientific man in regard to such phenomena as those of colour and sound, and these simpler cases were first adduced by the lecturer. He then pointed out that the statement is also true of all other material phenomena, and be specially dwelt on the phenomena investigated in the science of mechanics, showing that all the quantities treated of in that science, such as force and mass, prove, when the investigation is pushed far enough, to be expressible in terms of mere motion. He also showed that the prevalent conviction that motion cannot exist unless there is some "thing" to move will not stand examination. It proves to be a fallacious conviction traceable to the limited character of the experience of motions which we and our ancestry from the first dawn of organised thought on the earth have had within reach of our senses. This conviction accordingly has no authority with respect to molecular motions and to some others that have been brought to light by scientific study. He also showed that the "thing" which in common experience moves, proves in every case to be nothing else than these underlying molecular motions, the transference of which from place to place is the only kind of motion which common experience can reach, when unassisted by science.

The intermediate steps between the world external to our bodies and the brain which take place in our organs of sense and nerves can also be ascertained to be motions. And finally, a change consisting of motions takes place in the brain itself, whereupon we become conscious of thought: *i.e.* a change occurs within the brain which would be appreciated as motions by a bystander who could search into our brains while we are thinking, and could witness what is going on there, while all the time the change that we experience is thought. It must be borne in mind that our brain is a part of the external world to the bystander whom we have supposed to be observing what is going on in it. It thus appears that every phenomenon of the external world is reducible to motions and their modifications, while all that is within the mind is thought.

Now this motion to which all other material phenomena are reduced, this motion as it exists in nature, must be distinguished from man's conception of motion, which, after all, is one of his thoughts—a very complex one, no doubt, but not part of the external world. This particular conception in our minds is one remote effect of the motion as it exists outside us, and what we really know of that external cause is that it is a cause which does unfailingly produce this effect if the intermediate appliances of our senses and nerves are also present. Motion, the cause, must no doubt stand in absolutely rigorous relations to its effect, viz. our conception of motion: but it need not be like its effect, the presumption being quite the other way. The lecturer pointed out that, under these circumstances, the simplest and so far the most probable, hypothesis that can be advanced is the monistic hypothesis that this unknown cause is itself thought; and he pointed out that it is no objection to this view that we are unconscious of all the thought here supposed, for this is only to say that it is external to that particular group of interlacing and organised thoughts which we call our own mind, just as the thoughts of the many millions of our fellow-men and of all other animals are external to our little group.

[1] Short Abstract of Royal Institution Friday evening discourse (February 6), by G. Johnstone Stoney, M.A., D.Sc., F.R.S.

The lecturer accordingly recommended the following hypothesis: (1) as consistent with everything we know, (2) as the simplest hypothesis, (3) as an hypothesis which dispels all the difficulties that encumber the dualistic supposition that there are two kinds of existence, viz. the hypothesis that if a bystander were armed with adequate appliances to ascertain what is going on in our brain while we are thinking, then what we should experience to be thought is itself the remote cause with several intermediate causes of that change within the observer's brain which determines his having that complex thought which he would call perceiving some of the motions in our brain—in short, that what he appreciates as motion we experience to be thought.

If this view be correct, it will follow that the thoughts of which we are conscious are but a small part of the thought going on even in our own brain, and which would be seen by a beholder as motions, the rest being unconscious cerebration and as much outside our consciousness as are the thoughts of other people. We are led also to the conclusion that the thought which is going on in the brains of all the animals that exist is but the "small dust of the balance" compared with what is going on throughout the rest of the mighty universe.

## *SCIENTIFIC SERIALS*

THE *American Journal of Science*, February.—Obituary notice of Benjamin Silliman, son of Benjamin Silliman, the founder of that *Journal*, and long one of its editors, who died in his sixty-ninth year at New Haven, Connecticut, on January 14, 1885.—The organisation and plan of the United States Geological Survey, with a map, by J. W. Powell. The organisation, as at present established, comprises: (1) an a tronomic and computing division, the officers of which are engaged in determining the geographic coördinates of certain primary points; (2) a triangulation corps engaged in extending a system of triangulation over various portions of the country from measured base-lines; (3) a topographic corps, organised into twenty-seven parties scattered over various portions of the United States.—Memorial of the late distinguished botanist, George Bentham, by Asa Gray.—Palæontological notes on the material from the St. John group of New Brunswick contained in the Hartt Collection at Cornell University, by Charles D. Walcott.—On the rotation of the equipotential lines of an electric current by magnetic action, by E. H. Hall. The results are given of experiments made during the month of August, 1883, and at intervals since in the physical laboratory of Harvard College, the substances examined being chiefly copper, zinc, certain of their alloys, iron, and steel.—On the use of the term "Esker, or Kam drift," by J. Henry Kinahan. Both terms are traced to a Keltic source, *căm*, short (not *kāme*, long, as wrongly pronounced in England and the Lowlands), meaning, in Irish, *crooked* or *winding*, as in the river Cam, while *Eskir* or *Eiscir* denotes a small but well-defined ridge.—On the cause of mild polar climates, by James Croll. In this third paper the author discusses the climate of the Tertiary period in so far as affected by eccentricity, the evidence of climatic alterations and of glaciation during the same period.—Notice of the remarkable marine fauna occupying the outer banks of the southern coast of New England, by A. E. Verrill.—Note on a fossil coal-plant found at the graphite deposit in mica schist at Worcester, Massachusetts, by Joseph H. Perry.—The test-well in the Carboniferous formation at Brownville, Nebraska, by Prof. L. E. Hicks.—Review of Hill's supplement to Delaunay's "Lunar Theory," by John N. Stockwell.

THE *Journal of Botany* for February contains a plate of several new or rare species of Desmid to illustrate one of a series of papers on these organisms, by Mr. W. Joshua. It contains also the annual list of new flowering plants published in periodicals in Britain in 1884. Most of the other articles are descriptive.

*Bulletin de l'Académie Royale de Belgique*, December, 1884.—On the microscopic intrusions of sagenite in the titaniferous oolitic hematite of the clay-slates, by A. F. Renard.—On the external branchial apertures of the Ascidians, and on the formation of the intestine in *Phallusia scabroïdes* (new species), by Edouard Van Beneden and Charles Julin.—On certain new animal organisms forming a local fauna peculiar to the neighbourhood of Thornton Bank, by Ed. Van Beneden.—On the presence of *Niphargus puteanus*, Sch., in the Liége district, by Ed. Van Beneden.—Action of high pressure on the vitality of